

LETTERS TO THE EDITOR.

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The Inheritance of "Acquired" Characters.

DR. BASTIAN is unaccountably mistaken. Nothing in my letter indicates that I "assume (in the face of multitudinous difficulties) that the germ cells of all human beings are potentially alike." I have no doubt that germ cells differ, and therefore that the individuals which arise from them would vary even were they reared under absolutely identical conditions. These germinal differences between individuals and species are rightly termed innate. Individuals differ also because they are exposed to unlike influences during development. These differences, due to the unequal play of stimuli, are rightly termed acquired. But in my letter I did not allude to differences between individuals, nor even to acquired differences between one side of the body and the other. I merely discussed the question whether the terms "innate" and "acquired" correctly distinguished between certain *classes* of characters. I gave reasons for believing that a nose is no more innate and inheritable than a scar on it. If Dr. Bastian thinks I am in error, will he indicate in what sense the scar is less inborn and more acquired than the nose?

Often we are able to express our meanings very well by inaccurate terms the use of which has been sanctioned by convention. If, then, by "innate" and "inheritable" we merely imply characters which arise under the stimulus of nutriment no great harm is done. But, unfortunately, the words are usually given their literal meanings. The nose is supposed to be more rooted in the germ-plasm, more a product of evolution, more truly inborn than the scar; use acquirements are treated as trivial accidents unworthy the attention of the student of evolution; as a result, a very important phase of evolution is obscured and the study of it neglected. Dr. Bastian treats as absurd the belief that the bulk of human development after birth is an "acquirement." But, suppose we supplied an infant with sufficient nutriment but denied its body the stimulus of use and its mind the stimulus of experience, what sort of physical and mental maturity would the individual achieve? Would he develop nearly as well as the foetus in the uterus or the butterfly in the chrysalis? How many of his physical and mental parts would attain even the stage of development reached in a little child? Apart, however, from the precise degree in which the human being develops under the influence of use and experience, the points I wish to urge are:—(1) that a principal phase of the evolution of the higher animals is the evolution of a power of responding by growth to these stimuli; (2) that the characters which thus arise are in some species (e.g. man) of great magnitude; and (3) that they are just as much a part of "normal" development as the inborn traits. Variation renders a species adaptable. But the power of developing under the stimulus of experience confers adaptability on the individual as well. In his very interesting letter, Mr. A. Bacot refers to the "repertoire" patterns of "the peppered moth" (NATURE, January 30). Consider how many repertoire patterns are possessed by the human being, whom the environment may train to play the part of an acrobat or a clerk, a beggar or a king.

Dr. Bastian insists that "post-natal growth is essentially due to the same causes as pre-natal growth." His words sound well, but what do they imply in this connection—that use plays nearly as important a part in pre-natal as in post-natal development?

He declares that the memories of Chinese and Mohammedan children are exceptionally good, and accounts for this circumstance by the hypothesis that the memory (the *faculty* of learning as distinguished from the things that are learnt which are only the *contents* of the memory) grows in the individual with use, and that this acquirement is transmitted. Animals which are not protected and trained by their parents have little or no memory. It

would be of small use to them, for they must begin life fully equipped for the struggle by instinct. But in proportion as they are protected and trained, they are mentally immature on entrance into the world. The function of parental protection is to afford time and opportunity to make the acquirements without which they cannot attain maturity, and which in them in some measure take the place of instincts. The helplessness of the human being at birth, and the prolonged training necessary before he is able to maintain independent existence, is connected with the magnitude of his memory and the acquirements he makes by means of it. Now what is the evidence that memory (the faculty, not the contents) grows with use? So far as I am able to judge, memory, like the homologous power of growing physically, is greatest just when it is most useful—in the little child who has to equip himself with absolutely essential acquirements, and who, starting from a position of blank ignorance and incapacity, in a few months reduces the chaos of his world to order, and within two years even learns to walk and speak a language, as well as a vast deal more. Has Dr. Bastian any evidence that Chinese and Mohammedan adults are able to learn chapters of the Bible and the Koran more readily than their children? If, then, as seems probable, memory does not grow with use, how can the transmission of acquirements cause an increase of this faculty in a race?

Southsea, February 9.

G. ARCHDALL REID.

MR. BACOT's interesting letter (p. 294) on melanism in moths suggests that the moth I had seen in Yorkshire (though I knew it appeared elsewhere) has a "repertoire" of colours as an actor has a repertoire of plays, and each moth in his time plays many parts. But the actor learnt them all, and the moth apparently inherits them all, the result being the same, since each possesses them all, and according to environment each appears occasionally "in yellow stockings and cross-gartered," or "in customary suits of solemn black," so that while the actor's knowledge of Hamlet dies with him, the moth's repertoire is perpetuated by an ineradicable involution. The question that lies behind all this does not seem to be answered by reference to the operation of evolution in a "previous epoch," for evolution begs the question. If we say that evolution in the past packed the "germ plasm" with possibilities, and evolution in the present only unpacks here and there one as it is required, we seem to be illogical in the use of any argument founded upon such an uncertain term, for the evolution of an actor and the evolution of a moth are two totally and impossibly different things, yet the stimulus of environment produces the same results.

If we believe that the racial moth has plastic possibilities he may start with whatever form or colour you like, and he will, when it is good for him, become "peppered," and will continue peppered until it is bad for him, when he will become black or otherwise. But if he has to carry a whole load of inherent characters all the time, where, when, and how did his germ plasm "acquire" them? Is what was possible in the past impossible now? And, further, does not the geological statute of limitations forbid the possibility of "cramming" every plant and animal with all these inherent characters during the short time that most species exist?

Dr. Archdall Reid in his most thoughtful letter sends a breath of delightfully fresh air into the subject, for he suggests that, after all, the arguments on both sides of this fascinating subject are not about facts, but words, and suggests (p. 293) that "confusion, misunderstanding, and futile controversy" are due in this matter to the "use of inaccurate terms." The idea of his letter suggests the possibility of a complete explanation of this puzzling question.

If natural selection operated in the past by the slow development of racial possibilities until a fixed type was reached, and if "recapitulation" is established, the "adult" form at any stage short of the last must have had, like the imperfect individual, the power of somehow acquiring characters that it then passed on to its descendants; and if this be so it is difficult to believe that acquired characters are no longer transmitted, for in that

case no new type can possibly arise, and every plant and animal in the world is an "end group," which is utterly inconceivable from the evolutionary hypothesis.

Sunlight is pure and colourless. Under the stimulus of a prism it becomes red, yellow, and blue. If animal form and colour are no more than the prismatic separation of inherent characters preexisting in the germ plasma, it seems to me that the theory of "Darwinian" evolution falls to the ground, and that it is not logical to use arguments founded on that hypothesis to establish conclusions that are fatal to its existence; but I write with a certain trepidation, remembering the fate of the earthenware pipkin that ventured into the stream amongst the iron pots.

E. C. SPICER.

Waterstock, Oxford, February 1.

THE slightly dogmatic tone of my original article (January 2, p. 193) under the above heading has called forth quite a number of confessions of failure to understand the modern attitude towards this question. But, though we admire the generous spirit of those who have come forward and made a public exhibition of this failure, we consider that we have contributed our fair share by enticing them out into the open, and that they are asking too much when they try to relieve their very natural embarrassment by appealing to us to tell them what the modern attitude really is.

Ideally, of course, those who by inclination or accident are in touch with recent thought on these subjects ought to be only too glad to impart what they know to others less fortunate—to the aged and to the remote. But practically it cannot be done. The Editor of NATURE would say, perfectly rightly, that the correspondence column of his journal was not the place for enlightening those who fail to keep abreast of modern biological thought.

Dr. Archdall Reid's statement of the real nature of the problem is not a final one of course (as he probably thinks it is), but it is undoubtedly an improvement on the chestnut-old one which asserts that acquired characters are inherited as well as innate ones—a statement which is meaningless, because all characters are both acquired and innate.

If Dr. Bastian and Mr. Spicer have read that part of Dr. Reid's book, "The Principles of Heredity," which deals with this subject, their letters show that they have been unable to understand it. If they have not, it does not seem to us to be profitable to discuss the matter until they have.

A. D. D.

Atmospheric Electricity and Fog.

IN view of the interest recently shown in the subject of the dispersion or prevention of fog, it may be opportune to direct attention to a recent remarkable example of an atmospheric electricity phenomenon which usually accompanies London fogs. I should first explain that the method adopted at Kew for determining the absolute value of the potential gradient—i.e. the increase in the voltage per metre of height above the ground—certainly does not err in the direction of overestimating it. Taking eight years, 1898 to 1904, I found in a recent paper¹ that the mean value of the potential gradient at Kew was 159, the mean value for January being 201. The phenomenon referred to above is the occurrence during fog of specially high positive potentials, values double or treble that appropriate to the season being not unusual. At such times, however, there are usually large and frequent oscillations in the value of the gradient, so that the maintenance of an exceptionally high value for a number of consecutive hours is comparatively rare. On the morning, however, of January 21, during an intensely thick fog, the potential gradient at Kew exceeded 730 continuously from 1 to 9.30 a.m. How much it may have exceeded this value it is impossible to say, as the trace was beyond the limits of registration during the whole of this time. Both before the trace left the sheet and after its return the oscillations in the potential gradient were large, so that the maximum value was probably at least 1000.

A question of practical interest is whether the steepness of the potential gradient near the ground during fogs

¹ Phil. Trans., A, vol. ccvi., p. 299.

serves, or may be made to serve, a useful purpose in helping to clear the atmosphere of dust and smoke. It would also be interesting to know whether these high potentials are wholly without physiological effects on the human body.

CHARLES CHREE.

National Physical Laboratory, February 5.

The Penetrating Radiation.

MANY writers apparently assume that the penetrating radiation is due to γ -like rays coming from radio-active products in the ground, and is practically constant in amount. It seems probable, however, that the penetrating radiation comes largely from radio-active products in the air, and that it fluctuates greatly in value.

Taking the mean value found by Strutt and Eve for the radium content of sedimentary rocks as $0.9(10)^{-12}$ grams of radium per gram of rock, one finds that it is the source of γ radiation which would produce an ionisation on the surface of the ground in air of less than 0.8 ion per c.c. per sec. Now the above value for the radium content is perhaps large for surface soils subject to constant erosion. The actual value found by Cooke for the ionisation in air as due to the penetrating radiation was 4.5 ions per c.c. per sec. McClennan takes the value as 9, and the writer has found a much larger value in the open country during the warm hours of the day. Assuming that the emanation of the radium differs from a depth of 50 cm. or 60 cm. of the ground, one gets a penetrating radiation that will produce a much greater ionisation.

If the penetrating radiation is due to radio-active products in the air, one would expect that it would vary very greatly in amount. The experiments of Jaffe, Campbell, Wood, Borgmann, the writer, and others would indicate this. On the other hand, if the penetrating radiation comes from radio-active products in the ground, its amount should be quite constant. Dike has found that the active deposit which gathers on a charged wire exposed to the air varies greatly with the time of day. Eve, by his charcoal method, has found widely different amounts of the radium emanation in the air at different times. The writer (*Science*, July 12, 1907) has found that during a heavy rain or snow the penetrating radiation decreases very greatly in amount. Rain and snow have been shown to carry down radio-active products, and if the penetrating radiation is due to radio-active products in the air, then its value should be less during a heavy rain or snow.

If the penetrating radiation is due largely to radio-active products in the air, its value in underground cavities should be less than on the surface of the ground. This is what Elster and Geitel found. The writer has found the ionisation in a closed electroscope to be approximately the same (a) in a cave; (b) in a cistern where there was 4 feet of water on all sides of the electroscope; and (c) inside a screen of lead and cast-iron blocks. In the open country during August and September (1907) this same electroscope showed an ionisation during the day some three or four times greater than during the night. In the cave and cistern the ionisation during the day and night was the same. It is natural to suppose that the penetrating radiation was greater during the day, and was due to radio-active products which had diffused out from the ground. During the night the ionisation was not much greater than for the electroscope in the cave or cistern.

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W. W. STRONG.

Classification of Secondary X-Radiators.

THE relation between the character of secondary X-radiation emitted by elements when subject to the same beam of X-rays and the atomic weight of the radiating substance has been considered in various papers, but only brief reference has been made to the dependence of the character of the secondary on that of the primary radiation. We have recently made a more systematic study of the relation between the secondary and primary rays.

Although the behaviour of no two substances is exactly the same under the same conditions, yet substances may conveniently be divided into several groups, each consisting of elements which emit a radiation possessing many properties characteristic of that group.